ONTARIO WATER RESOURCES COMMISSION

Flavour evaluation of whitefish from Thunder Bay and Grand Portage Bay.

June 1970.

FLAVOUR EVALUATION OF WHITEFISH FROM THUNDER BAY AND GRAND PORTAGE BAY

by

David L. Wells

Biology Branch

Division of Laboratories

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INTRODUCTION

In a letter dated June 9, 1969 from Mr. D. Silvertson of Silvertson Bros. Fisheries, Duluth, Minnesota to Mr. H. Swinson of the Minnesota Division of Fish and Game the fact was noted that whitefish from Grand Portage Bay have been tainted with a foul oil-like flavour for several years. The incidence of tainting appears to be one fish in twenty. In a further letter dated June 26, 1969 from D. P. Caplice of the Ontario Water Resources Commission to Dr. C. H. D. Clarke of the Ontario Department of Lands and Forests, Mr. Caplice notes that for several years there have been complaints of tainted whitefish from Thunder Bay.

HISTORICAL BACKGROUND OF FISH TAINTING

The fact that fish can acquire unusual flavours or taints from the water has been demonstrated by Thayson(1935). In this study it was found that "Certain types of Actinomyces produce a pungent odour which has frequently been described as earthy." The contamination of the river under investigation was restricted to the tidal portion where the organic matter was abundant. His studies established that the taint appears to be acquired through the gills and to be carried in the blood stream although uptake through the gut was not discounted. A definite taint could be picked up by the fish in a few hours when they were exposed to tainted water but more than twenty-four hours in clean water was required before there was a noticeable drop in the flavour intensity.

Fetterolf (1964) suggests four avenues by which water borne substances may taint fish. These are:

1. uptake through the gills and into the blood
2. uptake through the gut and into the blood
3. absorption through the skin
4. adsorption to the mucosa.

Fetterolf concludes that uptake of tainting substances through the gills is the most likely route but he does not discount the possibility of uptake through the gut from tainted food. Working under the ice with rainbow trout (Salmo gairdneri) Fetterolf found that after two weeks of exposure, "the palatability of fish held within 0.5 miles of the waste discharge from a bleached kraft pulp and paper mill was significantly lowered". It was also suggested that tainting was more severe in late winter than in other seasons. The seasonality of tainting has also been mentioned by Baldwin et al. (1961) and Hasselrot (1964).

Baldwin states that over all seasons the fishes taken from below a complex of pulp and paper mills were rated significantly lower in aroma that those from other sources. This is also true for flavour. Hasselrot exposed pike (Esox lucius) for five days at various distances downstream from a bleached kraft mill. He found pronounced effects on flavour up to 4.3 miles downstream of the mill.

Van Horn (1961) lists adjectives describing flavours in fish taken from waters receiving pulp and paper mill effluent. The terms include musty, mouldy, paper-like, also medicinal, phenolic or kerosene-like. Van Horn's discussion of fish tainting is concluded with, "Laboratory experiments conducted over a limited period indicate that there was no flavour deterioration".

Beak (1963) states that "whitefish taken several miles below a pulp mill were rejected by commercial fisheries as

having a bad taste, yet when attempts were made to reproduce these experimentally using perch no positive result could be obtained except with crude turpentine at higher concentrations than would be found in the effluent".

Shumway (1968) exposed coho salmon (Oncorhynchus kisutch) to unbleached kraft mill effluent. Tainting was found after 75-96 hours of exposure at volume concentrations above 1.5% of untreated (not biologically oxidized) effluent. No flavour impairment was noted when fish were exposed to 2.9 volume percent,the highest concentration tested of biologically-oxidized effluent. The odour of the salmon from the untreated waste was described as "a combination between the odour generally associated with kraft mills and an odour reminiscent of domestic sewage. The latter rather repugnant odour was by far the stronger of the two odours".

Swabey (1965) demonstrated tainting in walleye (Stizostedion vitreum) collected from various locations in the Spanish River downstream of a bleached sulphate pulp and paper mill.

METHODS

Procurement of fish

The whitefish used in these flavour evaluations came from five separate areas. Control fish were obtained from Lake Nipigon. The experimental fish were from Green Point, four miles north-east of the mouth of the Kaministikwia River; Perry Point, 15 miles north-east of the mouth of the Kaministikwia River; Sturgeon Island, 10 miles south-west of the mouth of Kaministikwia River and Grand Portage Bay, 30 miles south-west of the mouth of the Kaministikwia River.

Twelve whitefish from Grand Portage Bay were received on October 15, 1969. Later the same month whitefish from Sturgeon Island, Green Point and Perry Point were received. In late March 1970, additional whitefish from Green Point and Lake Nipigon (control fish) were received. All fish

were held in a deep freeze until the day before testing.

Preparation of samples

Samples of approximately one cubic inch of muscle were taken from a fillet cut from the meatiest part of the fish between the dorsal and lateral fins. Skin and large bones were removed. The samples were placed in new, aluminum foil baking cups and were covered tightly with numbered pieces of aluminum foil. The numbers corresponding with those on a chart of the order of presentation of samples, known only to the author.

The samples were kept under refrigeration for a few hours until they were needed in the test. The cups of fish were placed on enameled trays and baked for 15 minutes at 300°F. The samples were then taken to the test room where they were kept warm under a heat lamp for a maximum of twenty minutes.

Taste panel

The personnel pool for the taste panel consisted of 13 people on the staff of the OWRC, Division of Laboratories. These people professed no dislike for fish and were able to attend the tasting sessions regularly. Six of the panel members had participated in previous tests, seven had not; three were smokers.

Taste tests

The four testing sessions were held in an unoccupied air-conditioned room on April 2 and April 3, 1970. The sessions were scheduled an hour after meals and panelists were asked to refrain from smoking prior to tests. Women judges were asked to remove their lipstick and each panelist washed their hands with odour-free soap before each test. All glassware and implements had been washed with odour-free soap and rinsed with distilled water.

Each panelist used an individual "place-setting" of a dish of unsalted crackers, waste containers, fork, paper cup, flask of rinse water, instruction sheet and response sheet. Rinse water was made by adding 1 tablespoon of lemon juice to 1 litre of distilled water.

For each session the judges were presented with a sample of warm fish marked C for control and seven samples identified only by number. They were instructed to taste the control fish, deposit the chewed portion of fish in a waste beaker, chew a cracker and rinse the mouth with the diluted lemon juice and place all waste in the containers. The numbered samples were then tasted in turn with a cracker chewed and the mouth rinsed between each sample. The presence or absence of foreign flavour as compared with the control was recorded as follows:

o - absent
+ - barely perceptible
++ - definite
+++ - strong

One unknown control was always included and several fish were duplicated during each tasting session.

RESULTS

Table 1 presents the data obtained on the incidence and intensity of foreign flavour in each specimen tested. In Table 2 these data are condensed to total numbers of samples tested from each location.

Through the use of a Chi square test the incidence of foreign flavour in the four experimental areas was compared to the incidence in the control fish. The total positive responses from Green Point, Sturgeon Island and Grand Portage Bay were significantly different from the control responses at the 95% level of confidence. Also, the definite to strong

responses from Green Point and Grand Portage Bay were significantly different from the controls at the 95% level of confidence.

Fish are considered to be strongly tainted when 2/3 of the flavour evaluations of that fish are rated as definite to strong. Three of the 38 fish tested were in this category, all from Grand Portage Bay.

The adjectives describing the fish flavours included woody, grassy, weedy, gasoline-like, oily (petrochemical) and kerosene-like.

Table 1. Incidence of foreign flavour in whitefish samples.

Collection area	No. of samples	Rating of fish flavour 0	+	++	+++	Total Positive	Total-Def. to strong
Lake Nipigon (control)	48	29	9	6	4	19	10
%	100	60.5	18.7	12.5	8.3	39.6	20.8
Green Point	78	20	30	17	11	58	28
%	100	25.6	38.5	21.8	14.1	74.4*	35.9*
Perry Point to Knoble Point	42	24	10	6	2	18	8
%	100	57.1	23.8	14.3	4.8	43.0	19.0
Sturgeon Island	84	34	29	10	11	50	21
%	100	40.4	34.6	11.9	13.1	59.5*	25.0
Grand Portage Bay	108	25	30	28	25	83	53
%	100	23.1	27.8	25.9	23.1	76.8*	49.0*

* Chi-Square values significantly different from controls at 95% level of confidence.

DISCUSSION AND CONCLUSIONS

Compared to the control fish of Lake Nipigon there was a significantly higher incidence of foreign flavour in the fish of Grand Portage Bay. Three of the thirty-eight fish tested from Grand Portage Bay would be considered as strongly tainted. This evaluation is reasonably consistent with

Mr. Silvertson's observations of one fish in twenty being strongly tainted. Tainting was also indicated in the fish from Green Point. The fish of Sturgeon Point show slight deterioration in flavour. Samples of fish from Perry Point did not reflect a tainting problem. This flavour evaluation has established on a controlled, objective basis what has been known subjectively for some time. Fish from Green Point and Grand Portage Bay are very likely to be tainted. The nature of the taint is inconclusive. Gasoline-like or kerosene-like taints are suggestive of industrial contamination especially where kerosene is used as a foam control agent in the pulp and paper industry. The grassy, musty and earthy taints are indicative of an abundance of actinomycete fungi growing on an organic bottom. Such a bottom may be found in Thunder Bay as a result of the pulping complex or at the estuary of the Pigeon River which is adjacent to Grand Portage Bay.

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Report prepared by:

David L. Wells

David L. Wells,
Biologist.

Report approved by:

C. F. Schenk

C. F. Schenk, Supervisor,
Biology Branch

APPENDIX I

Flavour Ratings and Incidence of Foreign Flavour in Samples

Table 2. Flavour Rating of Samples

Fish Number	No. of Samples	Rating of Flavour 0	+	++	+++	Total Positive	Total Def. to strong
Sturgeon Island							
Hg 482	6	xx	xxx	x		4	1
Hg 483	6	xxxxx	x			1	0
Hg 484	6	xx	xx	xx		4	2
Hg 485	12	xxxxx	xxxx	x	xx	7	3
Hg 486	6	xxxxx	x			1	0
Hg 487	6	x	xxxxx			5	0
Hg 488	6	xx	x	xx	x	4	3
Hg 389	6	xxx	xx	x		3	1
Hg 490	12		xxxxxx		xxxxxx	12	6
Hg 491	6	xxx	xx	x		3	1
Hg 492	6	xxxx		xx		2	2
Hg 493	6	xx	xx		xx	4	2
Total	84	34	29	10	11	50	21
Grand Portage Bay							
1	12		xxxx	x	xxxxxxx	12	8
2	6		xxx	xx	x	6	3
3	12	xxxx	xxx	xxx	xx	8	5
4	6	x	xx	xxx		5	3
5	6	x	xxx	x	x	5	2
6	12	xxxx xxx	xx	xxx		5	3
7	12	xxx	x	xxx	xxxxx	9	8
8	6	x	xx	x	xx	5	3
9	6	xxxx	x	x		2	1
10	12	xxx	xxxxxx	xxx		9	3
11	6	x	xx	x	xx	5	3
12	12		x	xxxxxx	xxxxx	12	11
Total	108	25	30	28	25	83	53

continued...

Table 2. continued....

Fish Number	No. of Samples	Rating of Flavour 0	+	++	+++	Total Positive	Total Def. to Strong
L. Nipigon (control)							
1	6	xxxxx	x			1	0
2	6	xxxxx		x		1	1
3	12	xxxxx	xx	x	xx	5	3
4	12	xxxxx xx	xxx	xxxx		7	4
5	6	xxxx	x		x	2	1
6	6	xxx	xx		x	3	1
Total	48	29	9	6	4	19	10
Green Point							
1	12	xx	xxxxx	xxxxx		10	5
2	12		xxxxxx	xx	xxxx	12	6
3	12	xxxx	xxxx	xx	xx	8	4
Hg 474	6	x	xx	xx	x	5	3
Hg 475	6	xx	x	xx	x	4	3
Hg 476	12	xxxxxx	xxxx	x	x	6	2
Hg 477	6	xxx	x	xx		3	2
Hg 478	6	x	xxxxx			5	0
Hg 479	6	x	xx	x	xx	5	3
Total	78	20	30	17	11	58	28
Perry Point to Knoble Point							
Hg 467	6	xxxxxx					
Hg 468	12	xxxxxxx	xxxx	x		5	1
Hg 469	6	xxx	xx	x		3	1
Hg 470	12	xxxxx	xxx	xxx	x	7	4
Hg 471	6	xxx	x	x	x	3	2
Total	42	24	10	6	2	18	8